THE WEATHER AND CIRCULATION OF JUNE 1965

Differential Motion of High- and Low-Latitude Wave Trains

JULIAN W. POSEY

Weather Bureau, Environmental Science Services Administration, Washington, D.C.

1. INTRODUCTION

June was a month of relatively pleasant weather on the average. No area in the United States was unusually hot for extended periods of time, and the arrival of summer assured that the observed below normal temperatures did not cause uncomfortable coolness except for a few mornings in northern sections. Drought persisted in most of the Northeast through June, but in the drought areas of Florida and the Plains heavy rain fell.

2. MEAN CIRCULATION

There was a marked decrease in wavelength of the middle-latitude westerlies from May to June (fig. 1 and [1]), and the trough pattern became more complex. A decrease in the zonal westerlies over the continents was a major factor in the formation of new waves. This diminution of the continental westerlies (fig. 2 and [1]) was more than just the normal seasonal weakening. Over North America a light easterly anomalous flow at the 700-mb. level in June replaced a light westerly anomalous flow in May between 35° and 55° N. Between 0° and 140° E. the anomalous flow at the 700-mb. level between 35° and 55° N. was more than twice as strong from the west in May compared to June. Over western United States the trough retrogressed about 10° longitude in June and deepened as part of the hemispheric pattern shift. This retrogression was in part associated with the loss of the trough located between 160° and 170° W. at the lower latitudes during May. Then, since the zonal flow was decreasing noticeably over North America, a retrogression of the western Atlantic trough occurred.

In contrast to the relatively light westerly flow over North America and much of Eurasia at middle latitudes, the oceanic flow at the same latitudes was stronger than normal. The subtropical anticyclone in the Atlantic was in about its usual location but was somewhat stronger than normal, while an anomalously deep Low persisted near Iceland with resultant fast westerlies in between the two systems (fig. 3). Also, in the Pacific a slightly stronger than normal low-latitude High was paired with a deep mean Low over the Aleutian Islands which gave wind speeds that averaged as much as 10 m.p.s. above normal for the month in the central Pacific.

At higher latitudes the wave number did not increase during June, but there was a shift in the location of the anomalies. The strong positive anomaly over Greenland in May was replaced by negative height departures, and an upper-level High appeared over the Arctic Basin with the 700-mb. height averaging 170 ft. above normal near the center. The full-latitude extension into western Canada of the deepening trough mentioned earlier in the western United States was associated with increasing 700-mb. heights over Hudson Bay and the appearance of an 80-ft. positive anomaly where heights were about 200 ft. below normal the previous month.

3. TEMPERATURE

The anomalously deep trough over western United States and resultant frequent cyclonic activity brought generally below normal temperatures to the western half of the Nation (fig. 4). Most of Arizona and small parts of adjacent States averaged more than 6° F. below normal. The moderation of the usual June warmth in Arizona and in California, where temperatures were 2° to 4° below normal, was mostly the result of the influx of polar air, for precipitation was relatively light in these areas. Over most of the other western States, the unseasonable temperatures resulted from a combination of precipitation and advection of cool air.

The blocking ridge from Hudson Bay to the Gulf of Mexico and associated light easterly anomalous flow over most of the eastern half of the United States deployed quite cool air southward from eastern Canada several times during the month. Only a few small areas in the East had slightly above normal temperatures in the average. In the Southeast the added effect of heavy precipitation caused negative temperature departures in excess of 4° F.

4. PRECIPITATION

In the drought area of the Northeast, which extends from the Washington, D.C. area through New England, there were beneficial rains as far as plant growth was concerned, but the extent and intensity of the rains were mostly below normal and did little to fill water reservoirs or replenish subsurface water tables. A severe drought condition still existed "in sections of southern New

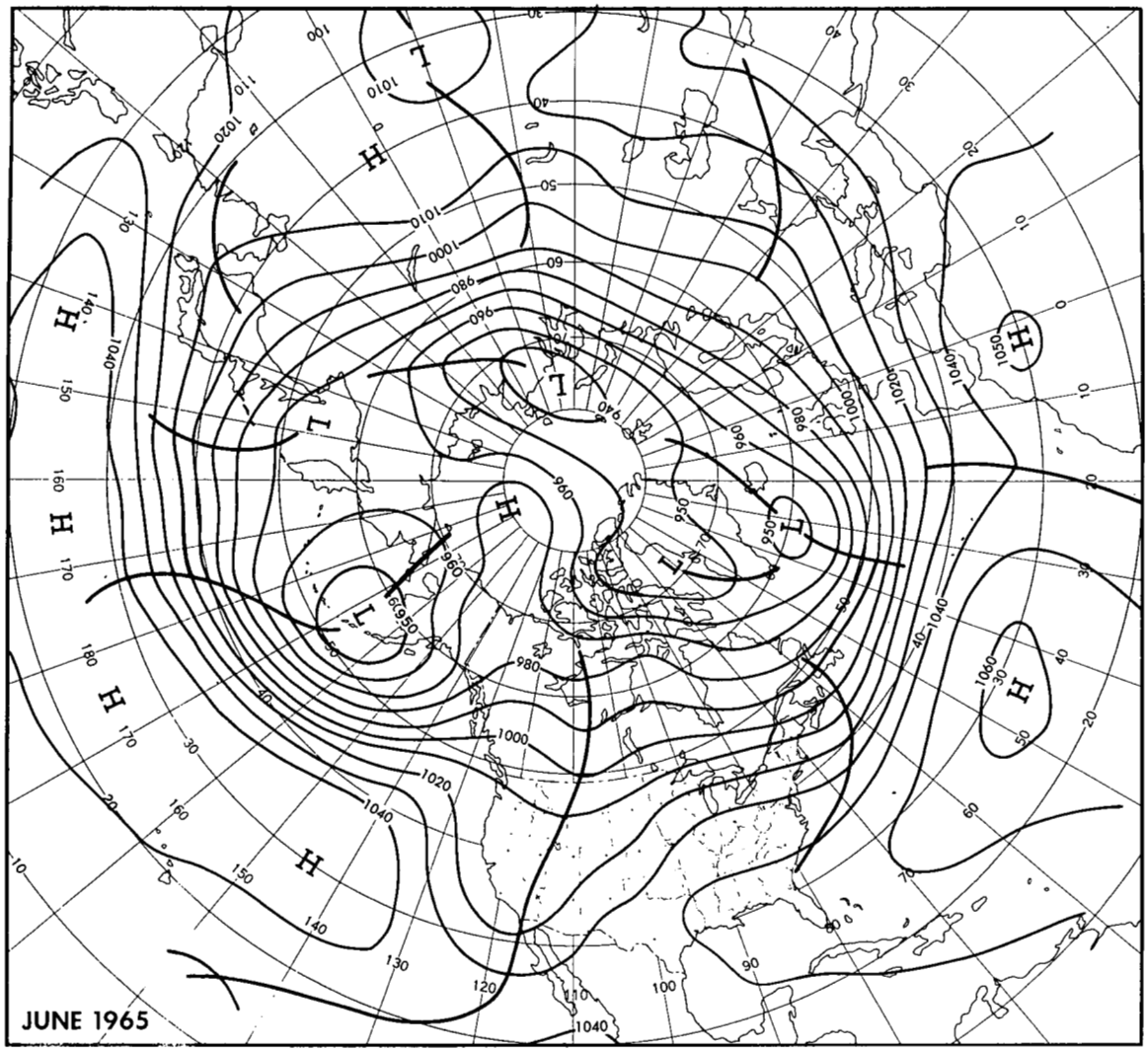


FIGURE 1.—Mean 700-mb. contours (tens of feet), June 1965.

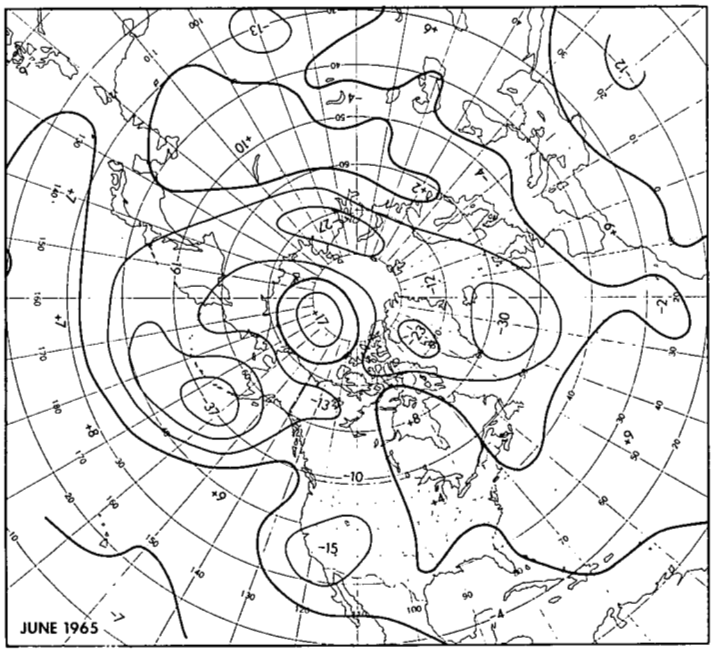


FIGURE 2.—Departure of mean 700-mb. heights from normal (tens of feet) June 1965.

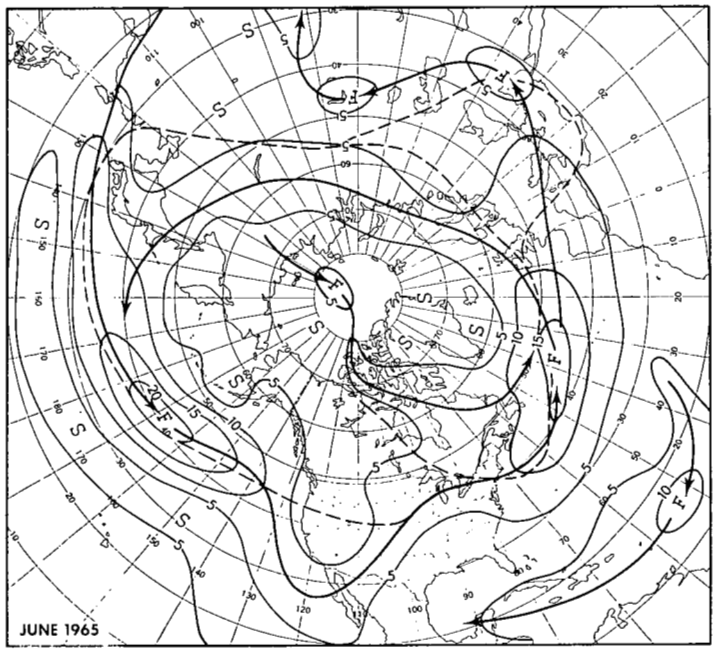


FIGURE 3.—Mean 700-mb. isotachs (meters per second) for June 1965. Solid arrows indicate principal axes of maximum wind speed and dashed lines the normal.

England, eastern New York, most of New Jersey, eastern Pennsylvania, northern Delaware, and northeastern Maryland" [2] at the end of June.

The drought in Florida and the west-central Great Plains was ended as far as agriculture was concerned with generous rain in June (fig. 5). Ample rains fell over most of the Southeast as far north as southern Virginia. Sections of the middle and upper Mississippi Valley also received very heavy rainfall, as did much of Montana.

Most of the Far West received either light or no rain as is usual for that section during June. The remainder of the Nation received light to moderate amounts of rainfall.

Some of the heavy rain in the Plains brought disaster. Severe flooding occurred in eastern Colorado, as well as adjacent areas of New Mexico and Nebraska, and in western Kansas. Damage from flooding was in the tens of millions of dollars, and reports indicated at least 15 lives were lost.

The cause of the heavy rains in the Plains and the Mississippi Valley was the deep trough in the west, while the heavy rains in the Southeast were associated with frontal activity and easterly anomalous flow in the upper levels. Greater detail of the causative factors of the precipitation will be given in the next section.

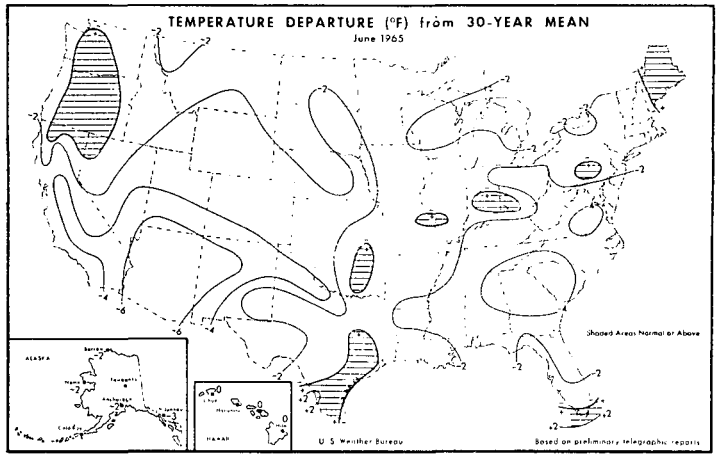


FIGURE 4.—Surface temperature departure from normal (°F.) June 1965 (from [2]).

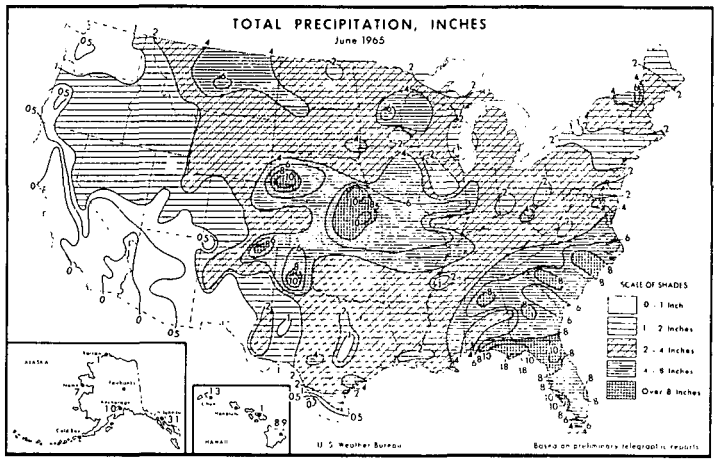


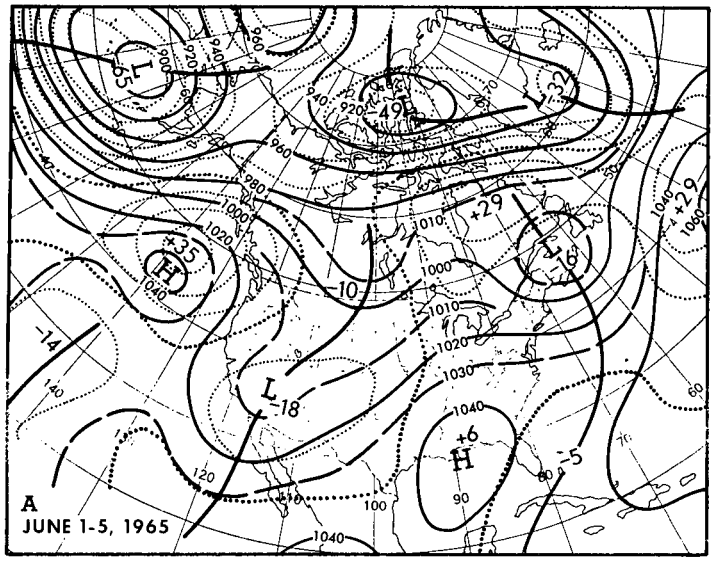
FIGURE 5.—Total precipitation (in.) June 1965 (from [2]).

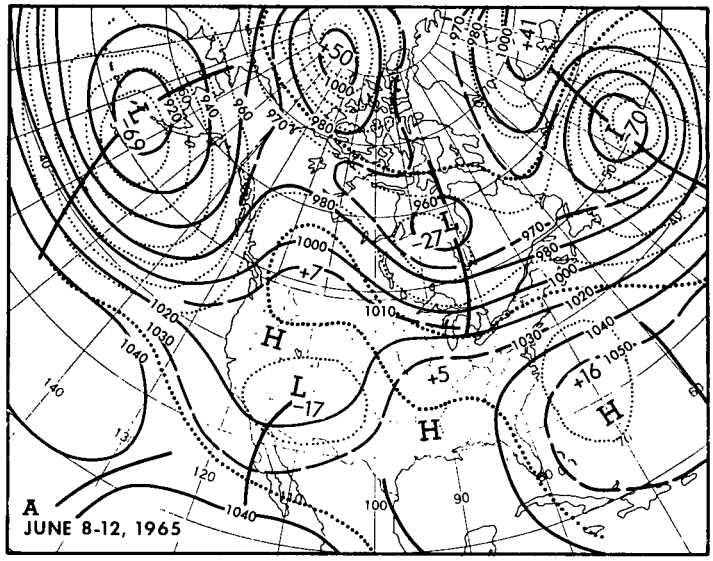
5. VARIATION OF THE WEATHER AND CIRCULATION WITHIN THE MONTH

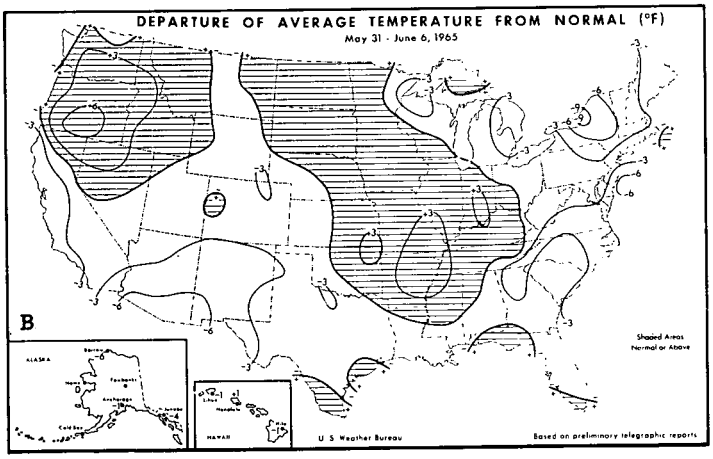
During the first week of June a strong 700-mb. ridge and associated positive height anomaly (fig. 6A) brought relatively warm and dry weather to the Northwest (fig. 6B and 6C). In contrast an anomalously deep trough gave up to 6°F. below normal temperature to the Southwest. A northeastward extension of the southwestern trough through the Plains into central Canada produced a long fetch of anomalous southerly flow that transported warm moist air from the Gulf of Mexico over the central part of the Nation. However, since 700-mb. heights were near normal and showers were widespread over the Central States, the warmest parts of this section were only slightly more than 3°F. above normal. Very heavy rains fell in Nebraska, Kansas, Missouri, and Minnesota, as migratory storms moved out of the Southwest from the deep mean trough. In the East a blocking pattern with a positive 700-mb. height anomaly centered east of Hudson Bay produced cool and relatively dry weather from Maine to Florida and westward over the Appalachians.

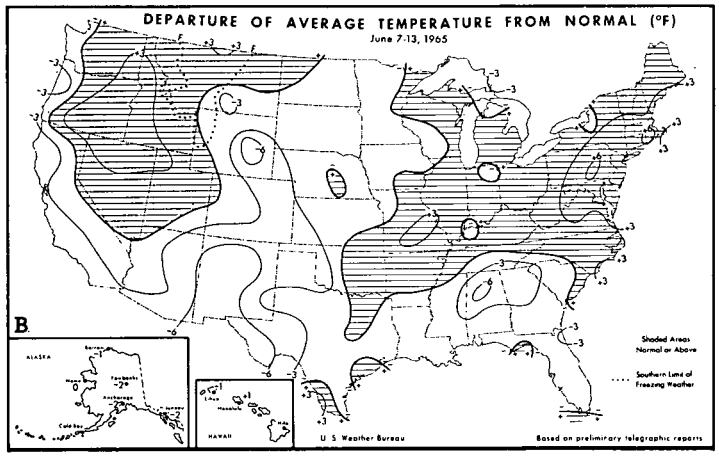
Differential motion of the various wave trains in the westerlies affecting North America the second week of June resulted in a ridge over western Canada out of phase with a sheared trough in southwestern United States (fig. 7A). At the same time the blocking pattern over eastern North America gave way to more westerly flow except in the Southeast where anomalous flow became easterly at 700 mb. The weak positive height anomaly in the Montana area and the easterly anomalous flow across the Rocky Mountains from Idaho to Colorado were the prime factors in giving above normal surface temperatures to the high plateau west of the Continental Divide (fig. 7B). Over the Northern Plains near normal 700-mb. heights were observed with near normal temperatures as should be expected, while the fairly large negative height anomaly associated with the cut-off Low gave as much as 6°F. below normal temperature to the southern Rockies and neighboring areas. Westerly flow brought above normal temperature to the Northeast replacing early June coolness, and a slight positive 700-mb. anomaly and the absence of much precipitation were the ingredients for the generally above normal temperatures in the Ohio Valley.

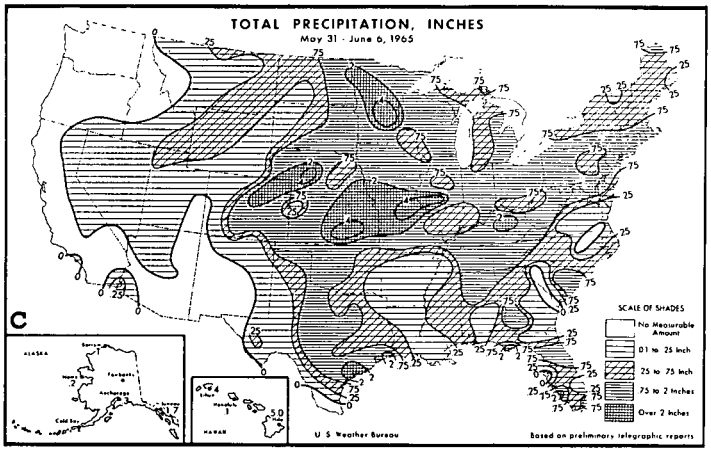
Easterly anomalous flow across the Gulf States and resultant increased cloudiness and precipitation caused below normal temperatures in that section. The heavy rains in the Central Plains (fig. 7C) were again associated with the southwest trough. In the Southeast heavy rain fell when a weak tropical disturbance moved out of the











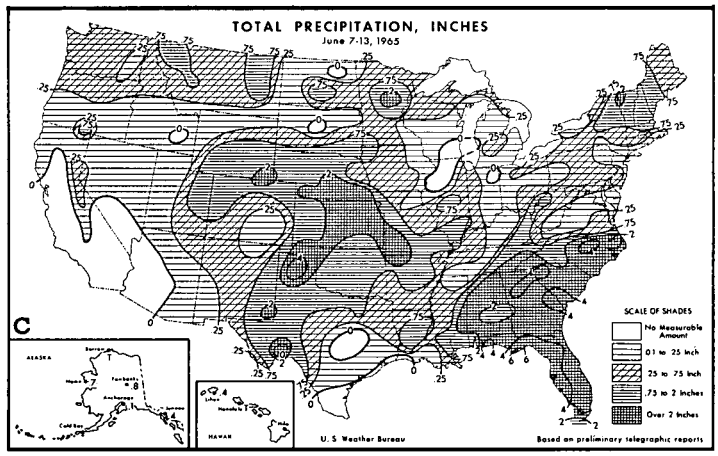
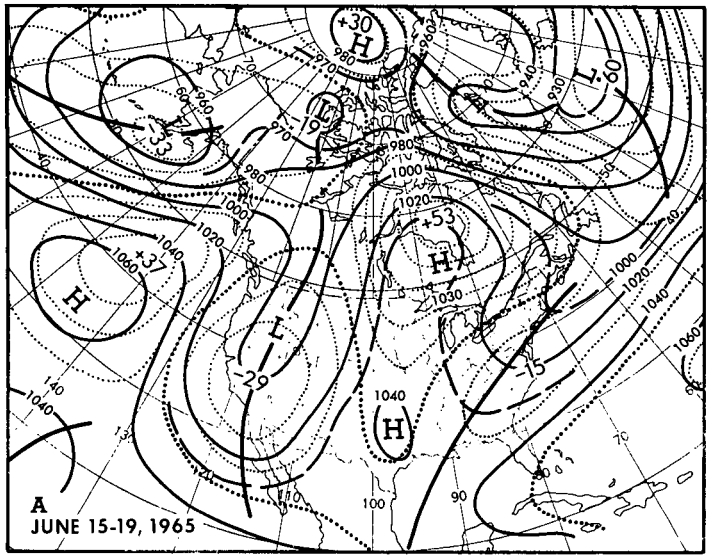


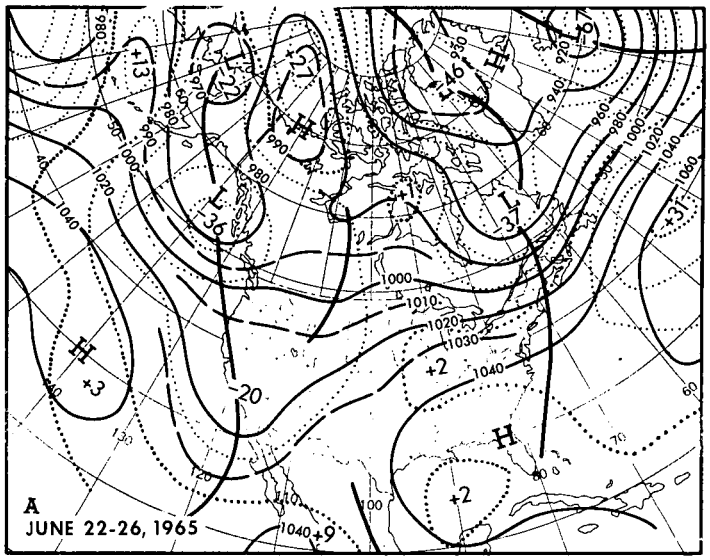
FIGURE 6.—Week ending June 6, 1965: (A) 700-mb. contours (solid) and height departure from normal (dotted), both in tens of feet, for June 1–5; (B) surface temperature departure from normal (°F.); (C) total precipitation (in.). (B) and (C) from [2].

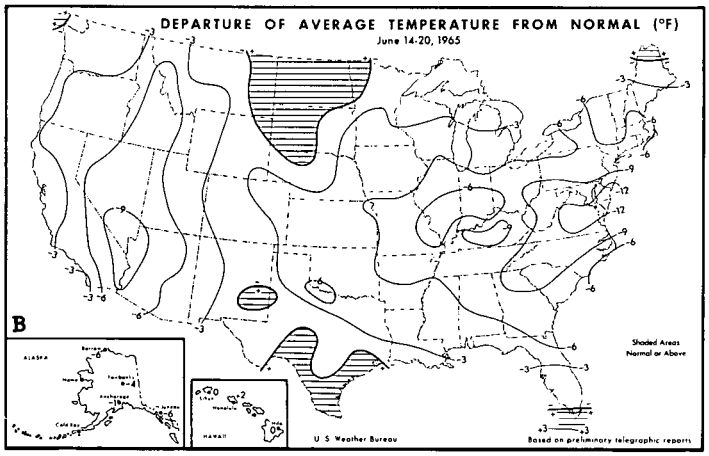
FIGURE 7.—Week ending June 13, 1965: (A) 700-mb. contours (solid) and height departure from normal (dotted), both in tens of feet, for June 8–12; (B) and (C) the same as figure 6.

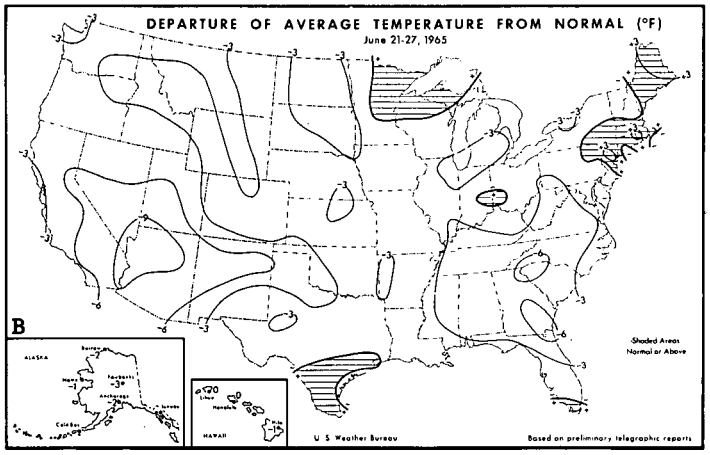
Gulf of Mexico through northern Florida, Georgia, and the Carolinas.

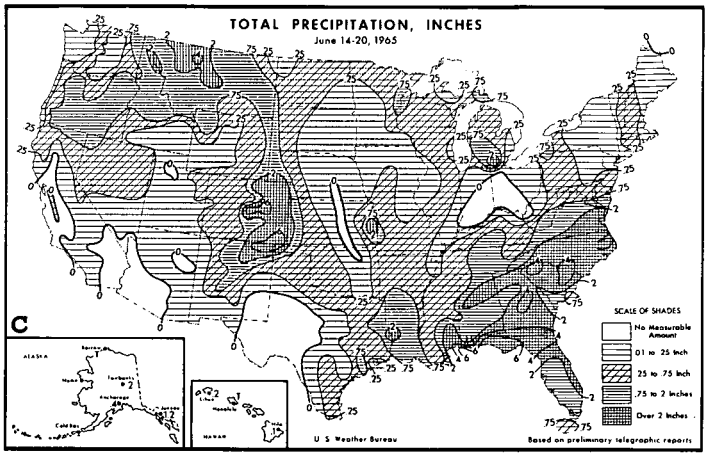
As the Canadian ridge continued its eastward progress while the lower-latitude High, shown in figure 7A over the lower Mississippi Valley, remained stationary, a third anticyclonic impulse in the form of a blocking wave was moving westward from Greenland at polar latitudes. Very strong amplification occurred when these three separate wave trains came into phase during the third week of June (fig. 8A). The intense positive upper-level











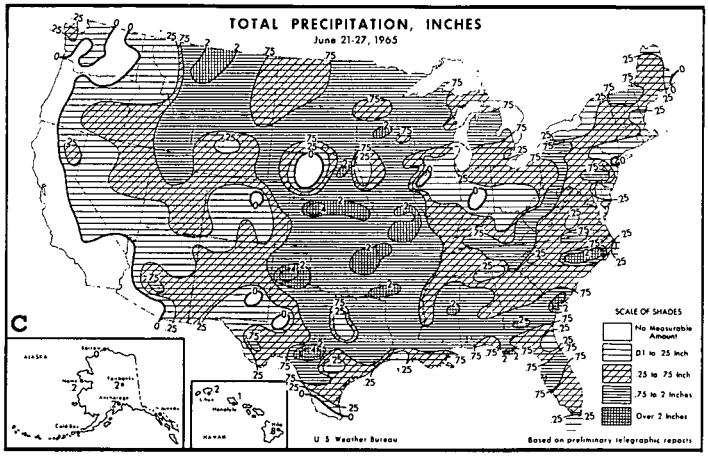


FIGURE 8.—Week ending June 20, 1965: (A) 700-mb. contours (solid) and height departure from normal (dotted), both in tens of feet, for June 15–19; (B) and (C) the same as figure 6.

FIGURE 9.—Week ending June 27, 1965: (A) 700-mb. contours (solid) and height departure from normal (dotted), both in tens of feet, for June 22–26; (B) and (C) the same as figure 6.

anomaly that developed over Hudson Bay and the accompanying surface anticyclogenesis caused strong cooling from the Plains eastward in the United States (fig. 8B).

Surface pressure in excess of 1032 mb. was first observed east of Hudson Bay on the 14th. Under the influence of a northeasterly upper-level flow this strong High moved southwestward to Minnesota before weakening and moving southward to the Gulf States. The full-latitude trough that formed over western North America in conjunction with the amplification increased the negative 700-mb.

height departures over the western United States and gave large negative temperature anomalies to the West also. Only the extreme Northern and Southern Plains had noticeable areas of slightly above normal temperature during the week ending on the 20th. Migratory Lows moving out of the deep western trough this week were shunted north and northwestward by the blocking ridge to the east. One of these storms brought the damaging floods to eastern Colorado and adjacent areas mentioned in Section 4 (fig. 8C). On the same days that flooding rains fell in Colorado, heavy rains were also falling in Montana showing the complexity of the large storm area. Low-level flow up the eastern slopes of the Rockies contributed to the heavy rainfall as well as the upward motion associated with the dynamics of the large-amplitude trough. Heavy rains also fell in connection with the mean trough over the Southeast which was a downstream response of the full-latitude trough and ridge pattern immediately to the west.

In the fourth week of June the differential motion continued with the ridge in the polar westerlies retrograding to western Canada, and the western trough again sheared. The northern portion of this trough moved eastward (fig. 9A), while the southern part retrograded and connected northwestward with a trough in the Gulf of Alaska. As the strong southerly flow over the Plains weakened in conjunction with the shearing trough, the ridge southward from Hudson Bay also weakened allowing a westerly 700-mb. flow and consequent warming in the Northeast (fig. 9B). An easterly anomalous flow and slightly below normal 700-mb. heights continued relatively cool weather in the Southeast. Below normal 700-mb. heights continued about the same temperature regime over the western half of the Country as was observed the week before. However, the trough advancing through the Northern Plains did cool the Dakotas about 3° F. In keeping with the trough and ridge de-amplification, precipitation in general decreased this week (fig. 9C).

6. TROPICAL STORMS

All three of the tropical disturbances observed in the western Pacific during June followed quite closely the steering flow shown in that area in figure 1. The first of these storms, Carla, was detected about 150 mi. southeast of Taiwan on the 1st, with winds of 50 kt. Carla was short-lived, moving northeastward and losing its tropical characteristics south of Kyushu on the 3d. A maximum wind speed of 120 kt. was reported on the 2d, and the storm maintained typhoon intensity for the remainder of that day. Typhoon Dinah was first observed as a tropical depression on the 10th northeast of Truk. Dinah passed close off the northeast corner of Luzon on the 17th. It then headed toward Taiwan with a peak intensity of 160 kt. As it moved over the east coast of Taiwan on the 18th, over the mountainous terrain, Dinah's winds dropped from 130 kt. to 35 kt. The storm killed 31 persons in Taiwan and later, as a dissipating storm over western Japan, caused floods that brought 14 additional deaths.

The final tropical storm in the western Pacific this month was Emma, which formed near 7° N., 140° E. on the 18th. Emma was not well organized at first as it drifted northwestward. By the 23d this storm was off the east coast of Luzon with 50-kt. winds and the next day reached a maximum intensity of only 55 kt. After moving northward about 200 mi. east of Taiwan, it dissipated approximately 150 mi. northwest of Okinawa on the 25th.

None of the three tropical storms observed in the eastern Pacific during June reached hurricane intensity. Wallie, the first of them, formed about 60 mi. off the Mexican coast near 15° N., 98° W. on the 16th. This storm was apparently caught in the steering flow of the deepening southwest trough at that time (fig. 8A) and crossed the coast of Mexico 65 mi. north of Acapulco on the 17th with winds of 40 kt. No damage reports have been received. The other two eastern Pacific tropical storms, Ava and Bernice, were located on the 28th and 29th, respectively, Ava being near 15° N., 190° W. and Bernice about 10° N., 97° W. Both of these storms were moving slowly northwestward at the end of June.

Only one tropical storm was observed on the Atlantic side of central America during June. This was the storm mentioned in Section 5 that moved out of the Gulf of Mexico through the Southeast. No name was given this tropical storm which was first detected off the Guatemala coast by a TIROS picture on the 11th. During the next 48 hours this disturbance moved northward at about 10 kt., passing into the Gulf of Mexico west of Merida. On June 14 reports from the weather buoy NOMAD of near-40-kt. winds qualified the circulation as a tropical storm. Sustained winds around 50 kt. and gusts to 65 kt. were observed at Alligator Point as the storm moved inland between Valparaiso and Panama City, Fla., on the morning of June 15 as an ill-defined Low. The storm became extratropical as it moved into the Atlantic on the morning of the 16th.

REFERENCES

1. R. R. Dickson, "The Weather and Circulation of May 1965—Severe Storms in Mid-Nation and Continued Drought in the Northeast," *Monthly Weather Review*, vol. 93, No. 8, Aug. 1965, pp. 528–534.
2. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin, National Summary*, vol. 52, Nos. 23–27, June 7, 14, 21, 28, July 5, 1965.

U.S. GOVERNMENT PRINTING OFFICE: 1965 O—783-716